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ABSTRACT

This paper reports on an investigation examining science classrooms in Korea from two perspectives: constructivism and student-teacher interaction patterns. The constructivist Learning Environment Survey (CLES) and the Questionnaire on Teacher Interaction (QTI) were used to obtain comprehensive information on science classroom environments. The study involved 10th and 11th grade students from three different streams, 145 grade 11 students from the humanities stream, 195 grade 11 students from the science-oriented stream, and 99 grade 10 students from the science-independent stream. Results indicate distinctive perceptions depending upon which stream students were members of. (Contains 41 references.) (YDS)

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High School Science Classroom Learning Environments in Korea

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High School Science Classroom Learning Environments in Korea

Introduction

This paper reports an investigation of science classroom environments in Korea, focusing on two aspects, namely, constructivism and the interaction pattern between students and teachers. This study made use of two questionnaires (Constructivist Learning Environment Survey, Questionnaire on Teacher Interaction) after a rigorous translation procedure by which those questionnaires could be suitable for the Korean context.

Educators in Korea have been concerned with constructivist notions in their quest to improve Korean education, which has maintained an examinations-driven curriculum (Han, 1995). These efforts resulted in a new science subject entitled 'KongTongKwaHak' (meaning integrated science) in the sixth curriculum reform in 1996. Despite a general concern with constructivism in Korea, no studies have looked at the constructivist nature of science classrooms in Korea. Also, there have been only a few studies dealing with personal relationships between high school teachers and students in Korea. Realising that these two concerns are aimed at creating a more effective learning environment, this study was undertaken to explore the current situation in Korea, by mapping the interaction patterns and emphasis on constructivism, which has been recently highlighted in the Korean curriculum.

Conceptual framework

The field of learning environment

The cornerstones of learning environment research can be found in the theoretical and conceptual foundations of Lewin (1936) and Murray (1938). Lewin assumed that the environment and its interaction with the person mainly determine human behaviour. This notion was extended by Murray with his needs-press model. According to Murray, personal needs, or 'motivational personality characteristics', represent the tendency for individuals to move in the direction of goals, and environmental press is the external situational counterpart that either supports or frustrates the expression of those needs. This model, developed within the field of psychology, was extended to teaching-learning situations (Anderson & Walberg, 1974; Moos, 1974; Rentoul & Fraser, 1979), and to a view of the class as a social system (Getzels & Thelen, 1960). With this previous background, psychosocial characteristics of learning environments have been conceptualised, measured and investigated using perceptions of students since the late 1960s (Fraser & Walberg, 1981). The field of learning environments has become established, as shown in various publications (Fraser, 1981, 1998; Moos, 1979, 1991; Moos & Trickett, 1974; Walberg, 1979) and these trends have been evident especially in science education (Fraser, 1998).

The constructivist perspective

Constructivism has made a strong impact internationally on the educational field for over 20 years (Driver & Oldham, 1986; Duit & Confrey, 1996; Hand, Treagust & Vance, 1997; Pines & West, 1986; Posner, Strike, Hewson & Gertoz 1982; Tobin & Tippins, 1993). In particular, science educators have been concerned with teaching strategies based on the notions of constructivism in an attempt to enhance students' conceptual understanding in science subjects. In many cases, these notions have been utilised as basic frameworks to reform traditional educational practices (Treagust, Duit & Fraser, 1996).

Teachers' interpersonal behaviour

As remarked by Getzels and Thelen (1960), the classroom is an involuntary educational milieu imposed by the school administration, which means that students must be together for set periods of time, accept the teacher, and carry out specific tasks. So, teachers tend to take the initiative of the classroom and normally lead the interaction in the classroom. Researchers in the Netherlands became interested in these interactions and their impact on the learning of students, and they developed the Questionnaire on Teacher Interaction (QTI). The QTI has been widely used in various contexts and has consistently indicated that teachers can make an important contribution towards creating a positive learning environment in classes through the way in which they interact with students (Fisher & Rickards, 1998;

Goh & Fraser, 1996; Henderson, Fisher & Fraser, 2000; Quek, Wong & Fraser, 1998; Wubbels & Levy, 1991).

Objectives of the study

In order to obtain a comprehensive image of science classroom environments in Korean high schools, this study was carried out with the following objectives:

- to validate an adapted Korean-language version of the Constructivist Learning Environment Survey (CLES) and the Questionnaire on Teacher Interaction (QTI)
- to describe students' perceptions about their interaction with the teacher and about the degree to which they experience constructivist approaches
- to investigate differences between three different streams (namely, the humanities, science-oriented and science-independent streams) in terms of students' perceptions of teacher-student interaction and emphasis on constructivist approaches
- to explore the unique and common contributions made by the QTI and CLES to variance in student attitudes.

Design and procedures

Sample

The sample consisted of grade 10 and grade 11 students (average age of 16-17 years) from three streams, namely, humanities, science-oriented and science-independent students. In the humanities stream, 145 grade 11 students were involved from 4 classes in 2 schools. In the science-oriented stream, 195 grade 11 students were involved from 4 classes in 2 schools. In the science-independent stream, 99 grade 10 students participated from 5 classes in the same school. The humanities stream students are not supposed to select science in higher education and are provided with relatively general content in all science subjects. On the other hand, science-oriented stream students are supposed to select science in higher education and are provided with more advanced content in each area. When it comes to the science-independent stream, students are provided with much more advanced content within a shorter time than other students in other streams. For each stream, a small number of representative students who showed specific response patterns in the survey were interviewed and some characteristic classes were observed for deeper analysis. As a criterion for selecting students, willingness to participate in the study and patterns in their answers to the questionnaires were considered.

Methods

While a sizeable proportion of classroom environment studies have involved assessment of student perceptions, recent studies have reported the effectiveness and potential of using multiple methodologies in this field (Aldridge, Fraser, Taylor & Chen, 2000; Fraser & Tobin, 1991; Tobin & Fraser, 1998). Advocates for multiple or mixed methods try to get a crystallised image of the target phenomenon which can be expected from various angles or viewpoints, by overcoming the dependency on any single method (adapted from Richardson, 2000). In particular, the methodologies were chosen in this study partly by focusing on the relationship between self and other, as described by symbolic interactionism (Blumer, 1969; Mead, 1963).

From the symbolic interactionism perspective, three methodologies used in the present study are understood as follows. First, survey is a way to provide a monologue, with limited description about lived experience. It can be understood as a way of looking at others with an objectivist view. In that case, the other just can select within limited possibilities.

The questionnaires in the present study were prepared through a pilot study. The use of surveys had two purposes: to enhance the soundness of the translated versions of two questionnaires (CLES and QTI); and to obtain information about the general characteristics of student-teacher interaction as measured by the QTI and about perceptions of the emphasis on constructivist approaches in their classrooms (CLES). All students responded to the Constructivist Learning Environment Survey (CLES) and the Questionnaire on Teacher Interaction (QTI). The CLES consists of five different scales, namely, Personal Relevance, Uncertainty, Critical Voice, Shared Control and Student Negotiation (Taylor, Fisher & Fraser, 1997). The QTI has eight different scales, namely, Leadership, Helping/Friendly,

Understanding, Student Responsibility/Freedom, Uncertainty, Dissatisfaction, Admonishing and Strict behaviour (Wubbels & Levy, 1991). Two questionnaires (CLES, QTI) were prepared through the process of translation and back-translation recommended by Brislin (1970, 1976).
Initially, the first author translated English versions into Korean. When the translation was done, each item was either *translated literally* or *translated with meaning,* as suggested by Newmark (1988). As the final step of translation, two English-speaking academics checked the back translations to make sure that the Korean questionnaires conveyed the same meaning as the English questionnaires. This translation process confirmed only the literal meaning transfer. After the translation process and subsequent pilot testing, instruments were administered to students. A pilot study involving each of the questionnaires was conducted to ensure that the translation of the questionnaires was appropriate and that students were interpreting items in the way in which they were intended. For some items, this necessitated the modification of the original English version, the Korean translation, or both. Insights from the pilot study guided revisions of the questionnaires for the main study.

Second, observation is a way of getting information about others, by self-seeing what is happening when others are experiencing their own lives. In this study, observation was used as a way of ethnographic inquiry in a natural setting called the classroom. In that sense, observation is a way to find out about aspects which might have been missed by survey and interview. During the observations, field notes and several photographs were taken. Initially, one of the researchers contacted some teachers in high schools. Some were reluctant to get their students involved, because they believed that students basically should not criticise or judge their teachers.

Third, interview is relatively direct communication, with a verbal description. It can also be understood as the verbal space where the self can interact with others, who can tell their stories with their own voices. While the interview is being conducted, it is possible for the self to impose her prejudice on others, accidentally. Even though the issues in interviews were selected from the questionnaires in my study, the issues were broadly given in the 'semi-structured mode'. This encouraged others to speak their minds. At the pilot stage, interviews were carried out to enhance the useability of the translated questionnaire. And, in the main study, semi-structured interviews were conducted to complement the survey results. For example, interview questions were based on the questionnaire and roughly rephrased to encourage students to elaborate their responses. And the researcher utilised two modes of interview: face-to face mode and e-mail mode. In the e-mail mode interview, follow-ups were done with a more extensive timeline than for the face-to-face mode.

Findings

Validation of CLES and QTI

First of all, validity and reliability of the CLES are reported in terms of four elements: factor structure (Table 1); internal consistency; discriminant validity; and ability to differentiate between classes (Table 2). In case of the QTI, due to its conceptual characteristics, only the pattern of inter-scale correlations (Table 3), internal consistency reliability and ability to differentiate between classes are reported (Table 4).

Table 1. Factor Loadings for Items in the CLES

Item No.	Factor Loading				
	Personal Relevance	Uncertainty	Critical Voice	Shared Control	Student Negotiation
1	.64				
2	.64				
3	.63				
4	.75				
5	.76				
6		.70			
7		.75			
8		.62			
9		.74			
10		.68			
11			.71		
12			.71		
13			.80		
14			.73		
15			.56		
16				.77	
17				.78	
18				.84	
19				.76	
20				.73	
21					.65
22					.81
23					.78
24					.76
25					.74
% Variance	10.72	11.06	10.84	13.40	12.62
Eigenvalue	2.68	2.77	2.71	3.35	3.16

Loadings smaller than .4 omitted. The sample consisted 440 students in 13 classes.

Table 2. Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation With Other Scales) and Ability to Differentiate Between Classrooms (ANOVA Results) for CLES Scales for Two Units of Analysis

Scale	Alpha Reliability		Mean Correlation		ANOVA Eta^2
	Ind	Class	Ind	Class	
Personal Relevance	.78	.94	.35	.59	.07**
Uncertainty	.79	.92	.36	.34	.08**
Critical Voice	.80	.90	.34	.45	.04**
Shared Control	.87	.91	.32	.22	.03*
Student Negotiation	.84	.91	.33	.60	.06**

*$p<.05$
**$p<.01$

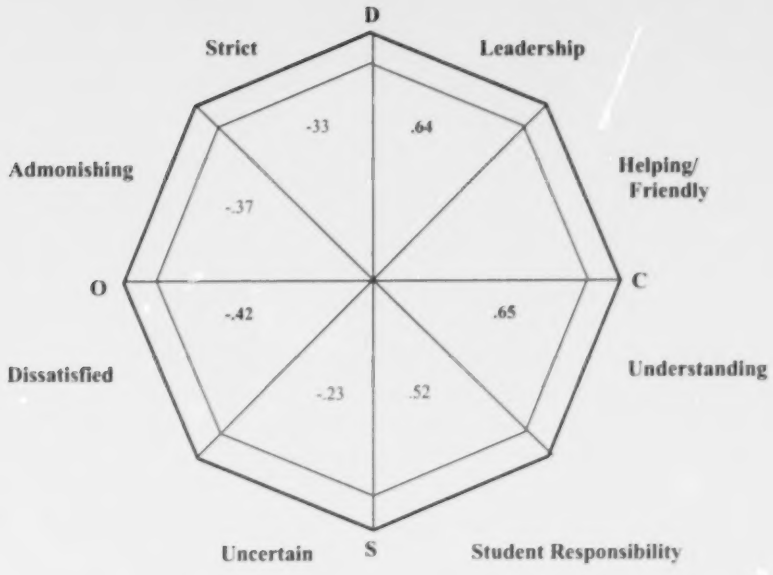

Figure 1. Profile of Scale Intercorrelations for Helping/Friendly Scale Using the Individual as Unit of Analysis

Table 3. Internal Consistency Reliability (Cronbach Alpha Coefficient) and Ability to Differentiate Between Classrooms (ANOVA results) for QTI Scales for Two Units of Analysis

Scale	Alpha Reliability		ANOVA
	Ind	Class	Eta^2
Leadership	.74	.79	.07**
Helping/Friendly	.77	.93	.09**
Understanding	.63	.86	.10**
Student Responsibility/Freedom	.76	.91	.12**
Uncertain	.81	.90	.15**
Dissatisfied	.55	.88	.17**
Admonishing	.64	.83	.09**
Strict	.60	.71	.11**

** $p < .01$

Table 1 reports the results of a factor analysis with varimax rotation for the sample of 440 students, indicating that the 25-item translated version of CLES assesses five different aspects of constructivism within the classroom environment. The factor loadings in this table are all greater than or equal to the conventionally-accepted value of 0.40. So, the results depicted in Table 1 support the notion that the 25-item translated version of CLES assesses five different aspects of constructivism within the classroom environment. The 25-item version was modified from the original 30-item version, by omitting negative items, in an attempt to minimise conceptual complexity.

Table 2 reports further validation information for the CLES based on its use in Korea. The Cronbach alpha reliability coefficient was used as an index of scale internal consistency, while the mean correlation of a scale with the other four scales was used as a convenient index of scale discriminant validity. Alpha reliability values for different scales with the individual student as the unit of

analysis ranged from .78 to .87, and from .90 to .94 using class as the unit of analysis. This suggests that all scales of the Korean version of the CLES possess satisfactory internal consistency. Another feature considered important in a classroom environment instrument is the discriminant validity of each scale of the instrument, that is, the extent to which each scale measures a dimension different from that measured by any other scale. In this study, the mean correlation of one scale with the other four scales ranged from .32 to .36 for the individual as the unit of analysis and from .22 to.60 for the class as the unit of analysis. These values can be regarded as small enough to confirm the discriminant validity of the CLES, indicating that each scale measures distinct, although somewhat overlapping, aspects of the classroom environment. Another desirable characteristic of the perceived form of any instrument like the CLES is that it is capable of differentiating between the perceptions of students in different classrooms. That is, students within the same class should perceive it relatively similarly, while mean within-class perceptions should vary from class to class. This characteristic was explored for each scale of the CLES using a one-way ANOVA, with class membership as the main effect. It was found that each CLES scale differentiated significantly ($p<.01$) between classes and that the eta^2 statistic, representing the proportion of variance explained by class membership, ranged from 0.03 to 0.08. These figures are relatively low and suggest that the learning environments of the different science classes in this sample are relatively similar to each other.

For the QTI, somewhat different statistical procedures from those used for other instruments were performed. Both factor analysis and discriminant validity analysis are irrelevant for the QTI, because of its conceptually idiosyncratic structure, which is based on Leary's (1957) circumplex model of interpersonal behaviour. Instead, the pattern of interscale correlations was calculated as another measure of the validity of the circumplex model of the QTI, as recommended by Wubbels and Levy (1993).

According to this model, the correlation of each scale should be highest with the scale next to it in the model and should become lower when scale moves away from it until they reach the lowest point (highest negative) with the opposite scale. Therefore, it is anticipated that there would be a high degree of overlap between some of the QTI scales. Figure 1 indicates that the Helping scale shows the highest correlation with the adjacent scale, Understanding (r =.65), and second highest correlation with the other adjacent score, Leadership (r =.64). And also the Helping Friendly scale shows the highest negative correlation with the opposite scale, Dissatisfied (r=-.42).
In addition to validating the QTI using the pattern of scale intercorrelations discussed above, the Korean version of the QTI also was validated in terms of internal consistency (Cronbach alpha reliability) and ability to differentiate between classrooms (ANOVA). The students' responses on the 48 items of the QTI were analysed using both the individual and the class mean as the units of analysis. As shown in Table 5, the reliability (Cronbach alpha coefficient) for different QTI scales ranged from .71 to .93 when using the individual as the unit of analysis, and from .55 to .81 when using the class mean as the unit of analysis. A series of one-way analyses of variance for each scale of the QTI gave an eta^2 statistic (which is the ratio of 'between' to 'total' sums of squares and represents the proportion of variance in scale scores accounted for class by membership) ranging from .07 to .17. The result of the analyses suggests that each scale of the QTI was able to differentiate significantly ($p<.01$) between students' perceptions in different classes. And these figures are much larger than those for the CLES, which suggests that teachers' interaction with their students are differently perceived by students in different classes. That is, teachers get along with their students in a relatively unique manner for each class.

The classroom environments of high schools in Korea

The average learning environment in Korean high school science classrooms can be represented with followings graphs based on students' responses to items in the CLES and QTI. Figure 2 provides a graphical representation of the mean scores for each scale of the CLES and Figure 3 provides a graphical representation of the mean scores for each scale of the QTI. In these figures, the average item mean (obtained by dividing the scale mean by the number of items in that scale) for each scale in the CLES for the whole sample is provided.

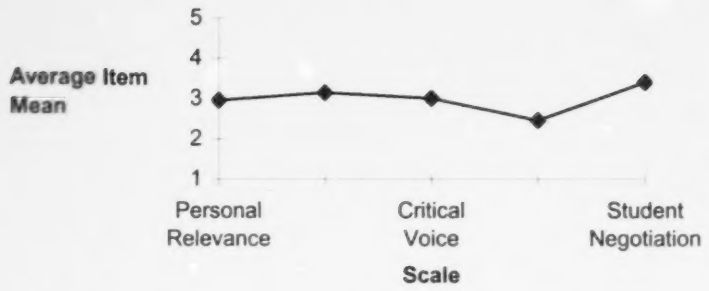

Figure 2. Korean High School Students' Average Item Means on the CLES

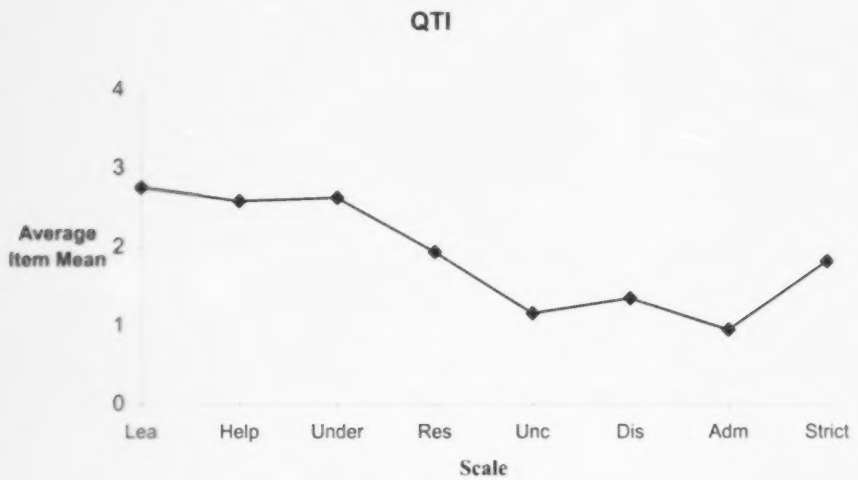

Figure 3. Korean High School Students' Average Item Means on the QTI

Figure 2 shows that students perceived that their science classes 'sometimes' reflect constructivist aspects, with the mean ranging being 2.5-3.5 (point 3 means 'sometimes'). The mean scores for Personal Relevance, Uncertainty and Critical Voice scales were near to 3, which imply that aspects described in these three scales occur 'sometimes' in their classrooms. In case of the Student Negotiation scale, students perceived that their science lessons 'more' than sometimes, but 'less' than often, reflect aspects related to Student Negotiation, and they perceived that Shared Control occurs less than any other scale. This result from survey was further investigated using two other modes of inquiry, namely, interview and observation. Differences in learning environment perceptions in the three streams were also considered, as described in the next section. Figure 3 indicates that, overall, students perceived that their teachers displayed cooperative behaviours (Leadership, Helping/Friendly, and Understanding) rather than opposite behaviours (Uncertain, Dissatisfied, Admonishing, Strict) in terms of interaction with them. These results for the QTI also indicate that Korean high school science teachers run their classes with fairly strong leadership and strictness, accompanied by a somewhat helping, friendly and understanding attitude, but that they do not display harsh and admonishing behaviour.

Differences between streams

The differences between streams are described as following graphs. To investigate the differences among humanities, science-oriented and science-independent streams, a one-way ANOVA was conducted for each scale in the CLES, SLEI, QTI and TOSRA. Firstly, for each scale, the *F* value from ANOVA was used to identify statistically significant differences between the set of three streams. For scales for which the *F* value was significant, *t* tests for independent samples were used to identify significant difference between each pair of streams (humanities stream and science-oriented stream, science-oriented stream and science-independent stream, humanities stream and science-independent stream).

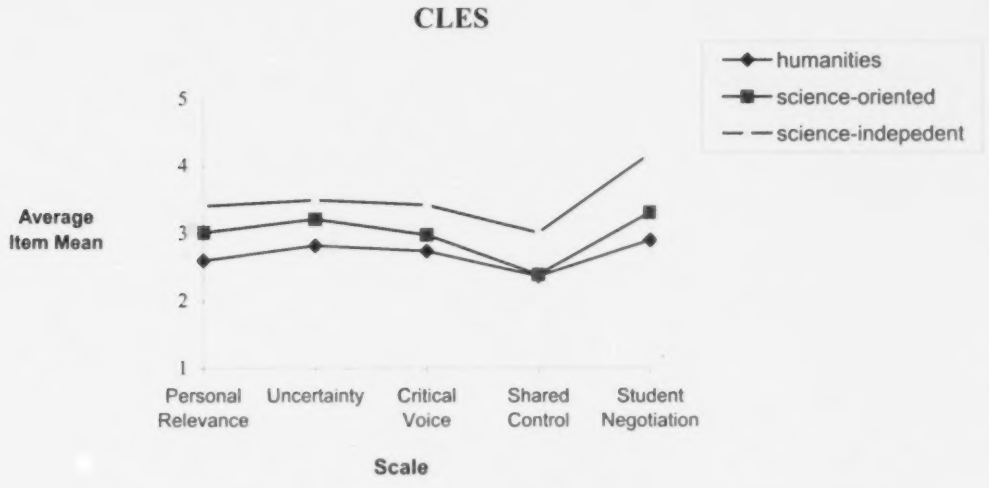

Figure 4. Differences Between Three Streams in Students' Average Item Means on the CLES

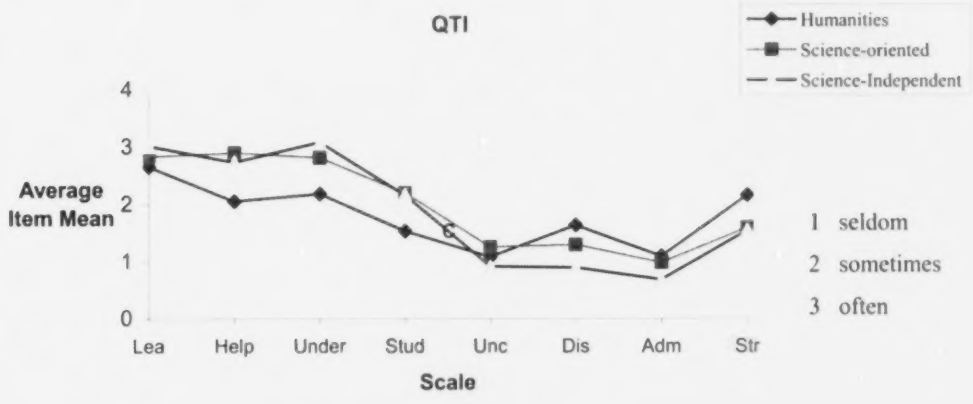

Figure 5. Differences Between Three Streams in Students' Average Item Means on the QTI

Figure 4 indicates that the most favourable CLES scores were obtained for the science-independent stream, the next most favourable scores for the science-oriented stream, and the least favourable scores were from humanities. Differences are greatest between stream 3 (the science-independent stream) and stream 1 (the humanities stream), as reflected in Figure 4, for all the scales. However, the perceptions of science-oriented stream students depended on the particular scale. For the Personal

Relevance and Uncertainty scales, perceptions of science-oriented students (stream 2) were similar to those of science-independent stream students (stream 1). For Critical Voice, Shared Control and Student Negotiation, the science-oriented students (stream 2) perceived their classrooms similarly to humanities stream students.

For the first four scales, the clear pattern is that humanities stream students have less favourable perceptions than for the other two streams. Science-oriented stream students perceived their classrooms more favourably than did the humanities stream students, but less favourably than did the science-independent stream students as reflected in Figure 5. Another feature reflected in Figure 4.8 is that teachers in the three streams 'often' (mean of 3) displayed cooperative behaviours and 'seldom' (mean of 1) displayed the opposite behaviours, except for Strict behaviour. Teachers were perceived to have fairly strong Leadership and to display relatively little Uncertainty in their lessons.

Lastly, the common and unique contributions of each environment questionnaire to the variance in student attitudes are reported in the next section.

Commonality analysis

Because two different environment measures were used simultaneously in the present study, the unique contribution of each environment questionnaire to variance in attitudes and the common contributions of pairs of environment questionnaire (CLES & QTI) to variance in attitudes were explored through commonality analysis. This method is widely used to estimate the unique and confounded components of variance explained in criteria by two or more sets of predictors. The unique and joint effects on attitudes of the two different environment instruments were explored in pairs, namely, the QTI and CLES.

Commonality analysis (Cooley & Lohnes, 1976; Pedhazur, 1982) was used to determine the degree of common variance shared by two instruments (QTI and CLES) in their contributions to student attitudes, as well as the unique contribution to variance made by each instrument. The purpose of these analyses was to ascertain whether these questionnaires each made a unique contribution to attitude variance over and above that accounted for by the other instrument. The importance of this aspect of the investigation was to shed light on whether there is any advantage in including the instruments together in the same study in future research.

Table 4. Commonality Analysis of R^2 Statistics for QTI and CLES for Attitudes using Individual as Unit of Analysis

Attitude	R^2 for individual students			
	Uniqueness		Commonality	Total
	QTI	CLES		
Social Implications of Science	.04	.06	.08	.18
Normality of Scientists	.03	.03	.06	.12
Attitude to Scientific Inquiry	.03	.06	.04	.13
Interest in Science	.05	.12	.10	.27

The results of the commonality analysis for each of the four attitudinal outcomes are given in Table 4. To determine the contributions of the QTI and CLES to the variance in Attitude to Scientific Inquiry, for example, the contribution to variance in Attitude to Scientific inquiry made by the QTI scales (.07) and by the CLES scales (.10) were subtracted from total contribution of all scales of the QTI and the CLES (.13). These figures indicate that the unique contribution of QTI scales is .03 (i.e., .13 - .10 = .03) and that the unique contribution of CLES scales is .06 (i.e., .13 - .07 = .06). The remaining contribution to variance in student attitude of .04 is common to the QTI and CLES scales. Those results indicate that teacher behaviour, as measured by the QTI, and the emphasis on constructivism, as measured by the CLES, are overlapping aspects of the learning environment in terms of their associations with student Attitude to Scientific Inquiry. Nevertheless, the CLES and the QTI each account for a reasonable

proportion of the variance in each of the four attitude scales, thus suggesting the usefulness of including both the CLES and QTI in future studies of student attitudes.

Summary of survey results

In summary, analyses of the survey data, collected by using the QTI and the CLES, suggest that the Korean versions of the CLES and the QTI have satisfactory reliability and validity for all scales when used in Korean high schools. For example, the QTI has Cronbach alpha reliability coefficients for different scales ranging from .55 to .81 with the class mean as the unit of analysis. And the CLES has alpha reliabilities ranging from .90 to .94 for different scales at the class level of analysis. Mean QTI scores suggest that the science teachers are directive, strict and not supportive of students' self-activities. It seems that a teacher's interaction with his/her students depends on his/her personal characteristics, rather than the stream the teacher taught.

Qualitative data from interview and observation helped to interpret the findings from the CLES and the QTI. That is, the findings from interview and observation elaborated and clarified the data from the QTI, but those data also showed some clashes with data from the CLES survey. During interview, differences between the three streams were clearly revealed, implying that the biggest difference between streams is the trust about students' self-study ability. In the science-independent stream's case, the teacher allowed students to do class tasks by themselves, based on the trust for students' self-study ability. In the science-oriented stream classes, students were concentrating on the lessons, but they showed some fear of being picked to give answers to the teacher's questions, because they did not want to be ridiculed for wrong answers. In the humanities stream, students were very passive in class. They were not confident in their answers when they were required to respond. Teachers did not wait for students to respond to their questions. It was presumed that teachers did not expect responses from students. Students in the humanities stream said that science lessons are just necessary 'evil' to them.

Deeper insights into students' responses to the CLES also were gained through interviews and observations. In some cases, information gathered from qualitative inquiry confirmed the quantitative findings. And, in other cases (especially, the Critical Voice and Shared Control scales), qualitative information conflicted with the quantitative findings. These discrepancies were explained in terms of cultural characteristics, the family background of individual students, and the current situation in Korean high schools. During observations, the researcher noted that, in classes in the science-independent stream, teachers appeared more receptive of students' talking and the lessons were mainly run using group activities. Students' cooperation was natural and did not require explicit interception from the teacher. Interviews also indicated that students from the science-independent stream were more likely to interact actively with their teachers than were students from the other two streams. It would appear that the stream in which students study influences their attitude towards their science classes. A student's selection of stream is based on his/her interests in science, which could influence their science-related attitudes.

In order to examine the magnitude of the amounts of variance in student attitudes explained by two different instruments (CLES and QTI), commonality analysis of the R^2 statistics were performed on the data, as recommended by Henderson, Fisher and Fraser (2000). To determine the contributions of the QTI and CLES to the variance in each scale in TOSRA, the contribution made by QTI scales and by CLES scales were compared with the total contribution of all scales in the QTI and CLES combined. Through commonality analysis, it was found that teacher behaviour (as measured by the QTI) and the emphasis on constructivism (as measured by the CLES) are somewhat overlapping aspects of the learning environment in terms of their associations with student attitudes. Nevertheless, the commonality analyses still suggest that it is useful to include the QTI and the CLES in future studies involving student attitudes.

Conclusion

The Korean version of the CLES (25-item version) exhibited the five-factor structure as originally intended. Due to the conceptual characteristics of the QTI, factor analysis was not appropriate. Instead, the pattern of inter-correlations between scales was calculated to see if they reflected the circumplex structure as originally intended. The internal consistency reliability of each scale of the CLES and QTI was satisfactory. Also, the discriminate validity (mean correlations of a scale with other scales in the same questionnaire) of the CLES was calculated to show that the scales within this questionnaire are

independent for use among Korean high school students. Each CLES and QTI scale also was found to differentiate between classrooms.

From the survey with the CLES, it was revealed that science lessons 'sometimes' conveyed the notions of constructivism as assessed by the five factors described in the CLES. This suggests that active implementation of constructivism in practice by teachers has been supported by various bodies (i.e., Ministry of Education, Science Teachers' Associations, etc.). The mean scores for Personal Relevance, Uncertainty and Critical Voice were near to 3, which imply that aspects described in these three scales occur 'sometimes' in classrooms. In the case of the Student Negotiation scale, students perceived that their science lessons more than 'sometimes', but less than 'often', reflect aspects related to Student Negotiation. Students perceived that Shared Control occurred less frequently than any other scale. These results from survey were further investigated using two other modes of inquiry, namely, interview and observation. Overall the survey results replicate a past study using the CLES in Korea (Kim, Fisher & Fraser, 1999) and provide further support for the reliability and validity of the CLES in Korea. Of the five scales which are assessed using the CLES, students' responses to the Shared Control scale showed a distinctively lower mean score than any other scale. Deeper insights into students' responses to the CLES were gained through interviews and observations. Information gathered using these methods confirmed the findings in some cases and modified the findings in others. The QTI results reflect that science teachers are directive, strict and not generous in allowing students' self-activities. This implies that the common thinking of Korean teachers is that self-activities of students normally are those which are distracting and bothering or even hinder learning. While some teachers are aware of the educational potential of students' self-activities, they soon find that it is practically impossible to implement those in their own classes, especially in senior high schools in Korea. Teachers have to handle large classrooms consisting of over 40 students. In order to keep the students attentive to teachers, they have to be strict and directive.

For the CLES, students showed distinctive perceptions depending on the stream in which they were. The differences were especially distinctive between science-independent stream students and humanities stream students. A comparison of the scale means between the three streams revealed that science-independent stream students perceived their science classroom more favourably than did students from the other two streams for all scales of the CLES. These differences were further explored using observation and interview. In the case of the QTI, each stream had its distinctive characteristics. And each pair of comparisons showed a statistically significant difference for many scales. The differences between streams reflected the unique nature of the individual teacher, in terms of his/her interaction with students, rather than representing each stream's unique nature.

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